Hudson River PCBs Site

Phase 1 Intermediate Design Report Attachment D – Determination of Depth of Contamination

Prepared by:

Quantitative Environmental Analysis, LLC

Montvale, NJ

Prepared for:

General Electric Company

Albany, NY

August 22, 2005

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List of Acronyms

CL	Confidence Level
DAD	Dredge Area Delineation
DoC	Depth of Contamination
GIS	Geographic Information System
IDL	Interactive Data Language
IDW	Inverse Distance Weighting
LWA	Length-Weighted Average
MAE	Mean Absolute Error
ME	Mean Error
MPA	Mass per Unit Area
NAVD88	North American Vertical Data 1988
OSI	Oceans Surveys, Inc.
PCB	Polychlorinated Biphenyl
RM	River Mile
RMSE	Root Mean Squared Error
SEDC	Supplemental Engineering Data Collection
SFSP	Supplemental Field Sampling Plan
SSAP	Sediment Sampling and Analysis Program
TIN	Triangulated Irregular Network
USEPA	United States Environmental Protection Agency

SECTION 1
INTRODUCTION

In accordance with the RD Work Plan (BBL 2003), the objective of Phase 1 dredge area delineation (DAD) was to identify those sediments within the Phase 1 Areas that meet the criteria for removal specified in the Record of Decision, as well as those specified in the United States Environmental Protection Agency's (USEPA's) Final Decision (USEPA 2004). These objectives are outlined in more detail in the Phase 1 DAD Report (DAD Report), which was approved by USEPA on March 30, 2005 (QEA 2005). In relation to the depth of dredging, a specific objective of the DAD was to determine depths of removal required to capture the PCB-containing sediments meeting the removal criteria within the delineated dredge areas. The DAD Report provided a detailed description of the methodology for establishing the horizontal and vertical boundaries of those areas meeting the criteria for removal, volume of contaminated sediments, and PCB inventory within those areas. The depth of contamination (DoC) was defined as the depth of sediment below which Total PCB concentrations are consistently less than 1 mg/kg. The DoC for each core was based on the measured Total PCB concentration data, Total PCB concentration extrapolations, or the doubled depth of the recovery of the core, as defined in the DAD Report. Kriging was performed on DoC estimates of each available core and resulted in a continuous surface over the river, indicating the thickness of sediment that met the criteria for removal, as per the definition of DoC.

Kriging, and most other interpolation schemes, use a weighted average of values at nearby sampled locations as the estimate of the value at each unsampled location. Thus, interpolated values fall inside the range of the neighboring measured values, always greater than the lowest value and less than the highest value. This behavior has two consequences: 1) the interpolated surface is smoother than the data from which it was derived; and 2) the interpolated values tend to exceed local measured values that are at the lower end of the distribution of measured values and to be less than local measured values that are at the upper end of the distribution of measured values. These consequences can be problematic if the measured values exhibit discontinuities (i.e., abutting regions where the within region variance is small in comparison to the cross-region variance) and if the region of interest is characterized by measured values at one end of the distribution. The kriging of DoC for purposes of dredge delineation was degraded by both of these factors. The boundaries between dredge areas and non-dredge areas tend to be boundaries between shallow sediments and deeper sediments and the DoC values inside dredge areas are at the upper end of the distribution of values within an interpolation domain. An illustration of this problem is shown in Figure D-1-1. This figure shows interpolated DoC contours established by kriging along with measurements of DoC for an area in the vicinity of Griffin Island. A clear discontinuity in DoC is seen between the non-dredge and dredge areas. Because of the influence of the low DoC values in the non-dredge area, the interpolated results in the dredge areas consistently underestimate the measured DoC values for individual cores. This is not a consequence of uncertainty associated with the DoC values within the dredge area. In fact, the data show that the DoC values within the dredge area are consistent such that DoC is known with good confidence. Rather, the under prediction by kriging is a consequence of including DoC values from the non-dredge area in the interpolation equation estimating DoC values within the dredge area when the data show a clear separation between these populations of data (i.e., the DoC data within the dredge area are not correlated with the data outside the dredge area).

Various alternatives to DoC kriging were examined in an effort to produce a DoC surface that exhibited less bias relative to the measured values. Unfortunately, all of the spatial interpolation models we examined were deficient to some extent because of the discontinuities mentioned above and the absence of a stationary spatial correlation structure over the domain of the interpolation. This latter issue is a general problem throughout the river. Spatial correlation appears to be very local and varies considerably from location to location. Furthermore, DoC is controlled by variables that cannot effectively be included in interpolation. For example, it was found that in certain areas, the DoC coincided with the top of the Glacial Lake Albany clay layer. However, attempts at cokriging DoC with the top of the clay layer and other variables did not materially improve performance of the interpolator.

The method to produce a DoC surface that appeared to have the least bias was to interpolate the Total PCB concentration in discrete depth intervals, overlay the interpolation results and define DoC by the top of the shallowest depth interval at which Total PCB concentration was less than 1 mg/kg and was also less than 1 mg/kg at all deeper intervals. Figure D-1-2 shows the results of this method (using Inverse Distance Weighting [IDW] as the interpolation model) for the same area near Griffin Island for which DoC kriging results are shown in Figure D-1-1. The interpolation of 1 mg/kg does a better job of matching the gradient in DoC that exists between the dredge area and the non-dredge area. Moreover, it provides a better match to the high DoC values found at the easternmost section of the area shown in the figures. On the basis of these types of comparisons, interpolation of Total PCB concentration at depth was chosen as the methodology to develop a DoC surface for use in intermediate design for Phase 1 Areas.

In addition, this Attachment presents an analysis to determine where DoC appears to extend to Glacial Lake Albany clay, the approach used to map the elevation of the surface of the clay layer, and the combining of the DoC surface and the clay surface to form a final DoC boundary for use in Phase 1 intermediate design. This Attachment summarizes the development and application of these two methods.

SECTION 2
DATA TREATMENTS

2.1 PCB DATA

All available data from the Sediment Sampling and Analysis Program (SSAP) and Supplemental Field Sampling Plan (SFSP), as well as all available data from data gap programs (i.e., QEA 2002, QEA 2003) were incorporated into the interpolation method (referred to as the 1 mg/kg interpolator throughout this document). In conducting the interpolation, data treatment was dependent on the Confidence Level (CL) of the core (as defined in the DAD Report [QEA 2005]):

- CL1, 2A, 2B, 2E, 2F, 2G: The Total PCB concentrations for all measured and extrapolated sections were used to the maximum depth (two times recovery depth). The Total PCB concentrations below the maximum depth were set equal to 0 mg/kg.
- CL2C and 2R: The Total PCB concentrations for measured sections were used to the depth to top of rock or clay. If there were no measured Total PCB concentrations from the recovery depth to the top of the rock or clay layer, the Total PCB concentrations reflects the absence of data. The Total PCB concentrations below the rock or clay layer were set equal to 0 mg/kg.
- CL2D: Total PCB concentrations for all measured sections were used. Below the last measured section, Total PCB concentrations were set equal to no data.
- CL2H: No measured Total PCB concentrations were used. Below probing depth Total PCB concentrations were set equal to 0 mg/kg.
- CL2I: Not used in the 1 mg/kg interpolator.
- CL2J: Below probing depth, Total PCB concentrations were set equal to 0 mg/kg.
- CL2K: Below probing depth, Total PCB concentrations were set equal to 0 mg/kg.
- CL2L: Not used in the 1 mg/kg interpolator.

Special considerations for some of these CLs are described in more detail in Section 3.2. The extrapolation applied to the Total PCB concentration in incomplete cores is described in Section 2.2.3 of the DAD Report (QEA 2005). In addition, in relation to the data gap data, agreed upon language (e.g., USEPA 2004) detailed the criteria to apply in order to determine whether the original core, the data gap core, or both cores would be used in the dredge area delineation and subsequent design. However, these criteria assumed that the pertinent information for delineation and design was surface PCB concentrations, MPA, and DoC. This new method for determining a depth of dredging surface does not directly consider each core's DoC. Instead, the focus of this method is on Total PCB concentrations within a pre-set number of depth intervals. As a result, in all cases, the measured Total PCB data for the original core and its paired data gap core were incorporated into the 1 mg/kg interpolation. Only the measured sections for the previously "dropped" core were used, while all measured and extrapolated (if applicable) sections of the kept core were used as per the rules described above.

2.2 RESPONSE TO USEPA'S MARCH 30, 2005 COMMENTS

On March 30, 2005, USEPA provided, along with the DAD Report approval letter, comments to be considered during dredge prism development in the Phase 1 intermediate design and preparation of the Phase 2 DAD. The following section addresses are the comments related to Phase 1 intermediate design. Although this Attachment is focused on determination of DoC, the following section addresses all comments from the USEPA's March 30, 2005 letter that pertain to Phase 1 intermediate design.

Comment 1: East Rogers Island Interpolation and Areal Extent of Dredge Delineation

USEPA recommended that separate interpolations be conducted for the northern, central and southern portions of East Rogers Island in order to honor the changes in flow direction as the river proceeds downstream. In response to this comment, the interpolation of the 1 mg/kg interpolation areas for East Rogers Island was conducted separately for the northern, central, and southern portions of this channel. However, the MPA and surface PCB interpolations were not adjusted and the areal extent of NTIP01 remained unchanged from the DAD Report.

USEPA recommended modifying the areal boundaries of the dredge area delineation near the Fort Edward Terminal Wall (i.e., the northernmost portion of NTIP02a). However, based on engineering considerations as described in Section 3.3 of the Phase 1 Intermediate Design Report, this area has been removed from the dredging program.

Comment 2: West Rogers Island Areal Extent of Dredge Delineation

USEPA recommended extending the dredge area in the northern portion of West Rogers Island to the shoreline. No adjustment has been made because the existing delineation is consistent with the delineation rule specifying that the results of the interpolator be followed unless ancillary data or PCB data that would support moving the boundary away from the interpolated boundary exist at an acceptable density. Moreover, the recommended extension would cover a shallow area with a bottom consisting of rocks and cobbles. In consultation with USEPA oversight personnel at the beginning of the 2002 field program, much of this area was deemed inaccessible for coring (Figure D-2-1).

Comment 3: Core RS1-9392-AR100 Meeting Select Criteria

USEPA requested that surrounding cores be considered to determine whether a core in the vicinity of River Mile 193 (Core RS1-9392-AR100) meeting the "Select" criteria should be treated as a "Select" core. USEPA noted that this core has a double peak and therefore might not be indicative of an area of burial. The data from this core do meet the Select criteria, as interpreted by USEPA (i.e., maximum Total PCB concentration in the top 12 inches below 5 mg/kg and a peak buried below 24 inches) and has been treated as such. All of the Total PCB concentrations in samples from this core are below 10 mg/kg, thus the double peak results from Total PCB concentrations of 3.9 mg/kg in the 0-2 in. segment and 7.9 mg/kg in the 36-42 in. segment and do not provide strong evidence that this area is not an area of burial.

Comment 4: Depth of Contamination

GE assigned a DoC of 6 in. to all samples with probing depths that were less than or equal to 6 in. However, as indicated by the USEPA, these locations could have DoC set to their probing depth. As a result, the samples shown in Table 1 of USEPA's comments were incorporated into the 1 mg/kg interpolator with the measured Total PCB concentration assigned to a depth interval from the surface to the probing depth. Below the probing depth for these locations, the Total PCB concentration was assumed to be 0 mg/kg.

USEPA also discussed three cores that have reporting limit issues (USEPA Table 2) and indicates the DoC of these cores can be adjusted for intermediate design. However, given the new method for establishing DoC (i.e., Total PCB concentration interpolation at depth), this adjustment is unnecessary. The Total PCB concentrations for all sections that had reporting limit issues were adjusted as per USEPA's Final Decision (USEPA 2004) and the data were used in the 1 mg/kg interpolation.

The final portion of USEPA's Comment 4 relates to uncertainty. As discussed in Section 1 of this Attachment, the DoC surface derived from kriging is inadequate for dredge prism development and this Attachment presents the approach used instead. The uncertainty estimates of DoC provided by the kriging model do not provide a means to improve the kriging DoC surface because they are subject to the limitations caused by differences in the spatial structure of the data and the assumptions of the model. Thus, these estimates cannot be used to provide a reliable estimate of a "conservative" DoC surface. As discussed in Section 3.4.2 of the Phase 1 Intermediate Design Report, the data are inherently conservative and it is likely that a DoC surface consistent with the data is conservative. The approach used to develop dredge prisms produces such a surface and no adjustment of the surface to depths greater than that indicated by the data is warranted.

Comment 5: Other Comments Related to Dredge Area Delineation

USEPA indicated that two exceedances on the east shoreline below Lock 7 should be included in a dredge area. However, these two points are surrounded by cores below the criteria and are considered isolated. Therefore, the dredge area was not revised.

USEPA indicated that the DAD Report did not provide the "requested level of justification" regarding historical cores and those cores identified as "inconsistent". Section 2.7

of the DAD Report details the evaluation of the historical core data and the arguments supporting the treatment of these data, while Section 2.2.4.1 of the DAD Report discusses the analyses conducted that led to labeling of certain data as "inconsistent". In addition to the justification provided in the Phase 1 DAD (QEA 2005), we note that excluding historical data from the dredge delineation has no material effect on the delineation. Of the six historical cores in the Northern Thompson Island Pool for which MPAs could be confidently calculated, five are within dredge areas and do not provide an indication that areas outside the dredge areas met the removal criteria at the time the historical cores were collected. Similarly, all of the four historical cores in East Griffin Island are within dredge areas. Additionally, the historical cores within dredge areas would not have significantly influenced the boundaries established by interpolation because most have MPAs similar to the values for neighboring SSAP cores and tend to be overwhelmed by the large number of SSAP cores in the local area. Regarding the inconsistent cores, in the February 3, 2005 letter from GE to USEPA, GE agreed to relax the tolerance for the classification of cores with inconsistent data to be cores where the lab recovery is more than five inches greater than the penetration depth and the lab recovery is more than five inches greater than the field recovery, because of USEPA's concerns related to the potential for measurement errors in the field recovery. The differences in the Total PCB concentrations and the textural descriptions between the core identified as containing inconsistent data and the 2004 data gap core support the use of the data from the data gap core only.

The last comments relevant to the Phase 1 intermediate design received from USEPA on March 30, 2005 were related to data gap core pairs, in which the DoC and MPA of a paired core were not used in delineation. Specifically, USEPA found 10 core pairs in which the dropped core has a measured end depth that is greater than the DoC of the core that was used; USEPA found 22 core pairs in which the dropped data gap core has a higher MPA than that of the core that was used.

For the method presented here for DoC determination, the measured Total PCB data for both the data gap core and the dropped core were used in the interpolation of Total PCB at depth. However, a response to USEPA's comment is provided here for completeness. USEPA provided a list of 13 core pairs (3 additional than the original 10 mentioned in the March 30, 2005 comments) in a follow up email received on May 20, 2005. Of those 13 cores, 6 of the dropped cores have been reintegrated into the intermediate design (see Table D-2-1), including 2 cores that are located within "clay areas", and 7 are still dropped for the reasons given Table D-2-1.

Table D-2-1. Dropped data gap cores highlighted in USEPA's March 30, 2005 comments.

Core ID	New Treatment	Comments
RS1-9089-ET063	None	Core in "Clay Area". Original core had clay at 6 in.; data gap core had clay at 5 in. and DoC at 2 in. Data treatment correct.
RS1-9392-IN067	None	Peak TPCB concentration at the bottom of new core. DoC for old extrapolated to 14 in. This is equal to the depth of the last measured section in the new core.
RS1-9392-WT071	CL2F	Core extrapolated.
RS1-9392-WT127	CL2F	Core extrapolated.
RS1-9392-WT228	CL2F	Core extrapolated.
RS1-9392-WT286	None	Original core had only one sample (0-2 in.). Data gap core has a DoC and the clay layer at 2 in.
RS1-9493-WS110	CL2F	Old core has a nearly classic PCB profile. Core extrapolated.
RS1-9493-WS111	CL2F	Old core has a nearly classic PCB profile. Core extrapolated.
RS1-9493-WS603	None	GE identified this as a clay core with the DoC at 9 in. USEPA extrapolated the DoC to 34 in. Core in "Clay Area". Data treatment correct.
RS1-9493-WT256	None	DoC in data gap core is 2 in. Original core only sampled from 0-2 in. Data treatment correct.
RS1-9594-WS603	None	GE identified this as a clay core with the DoC at 9". USEPA extrapolated the DoC to 34 in. Core in "Clay Area". DoC determined by top of clay layer.
RS1-9594-WT086	None	Old core is a short core with an inconsistent profile. GE does not propose to use the data from the old core for determining the DoC.
RS1-9594-WT171	CL2F	Old core has a nearly classic PCB profile with the exception of the bottom layer (30-34 in.). Core extrapolated.

In addition, the areal interpolation and delineation were not redone to accommodate the 22 incomplete cores not used in delineation that have measured MPAs greater than their paired core that was used in delineation. For some of the 22 dropped data gap cores, our calculations result in different MPAs than those shown in the file provided by USEPA on May 20, 2005. In many of the cases, the dropped data gap core would not have a significant impact on the dredge delineation because the core is located well within the dredge area boundaries and/or the difference in MPA between the dropped core and the kept core is not significant. However, GE will reconsider the unextrapolated MPAs of these dropped data gap cores when making any adjustment to the areal delineation in the Phase 1 Areas during the analysis of the 2005 data gap sampling results.

2.3 IDENTIFICATION OF THE INTERFACE BETWEEN SEDIMENT AND GLACIAL LAKE ALBANY CLAY

As described in Section 1 of this Attachment, it was determined that in certain portions of the river, the DoC extends to the top of the Glacial Lake Albany clay layer. Glacial Lake Albany was formed approximately 15,000 years ago when water melting from the edge of a glacier was dammed by glacial debris (http://www.skidmore.edu/sssg4/environment/geology.htm). Glacial Lake Albany occupied the Hudson River Valley from Poughkeepsie to Glens Falls. Clay and sand were deposited on floor of the glacial lake. Seasonal variations during deposition resulted in the varved or rhythmically bedded clays and silts, although this layering is not present in all locations and throughout the entire thickness of the clay deposits (Cadwell 2005).

The top of the glacial clay at each sample location was determined by looking at the textural and general descriptions from the SSAP core or Supplemental Engineering Data Collection (SEDC) boring at that location. This was done using the following systematic approach:

- Cores with Clay "CL" as the primary textural description were identified. The top of the segment was noted.
- If the textural description also contained gravel, organics, coarse sand or medium sand, the core was flagged and the core profile was reviewed in detail to evaluate if the clay could be determined to be Glacial Lake Albany clay.
- Cores with Clay or "CL" in the general description were identified. Any depth associated with the indication of clay was noted. The core profile for each of these cores was reviewed in detail.
- For cores with clay in both the general description and the primary textural description, the associated depths were compared. If the depths did not match, the core profile was reviewed in detail.
- The depth to the top of clay was determined. If it could not be definitively determined that a core contained the Glacial Lake Albany clay, the core was flagged as uncertain, and no information was used from this core.

- If there was no indication of clay in a given core, the bottom of the last segment in the database was identified as the depth which the clay layer could not be above for that location.

2.4 CREATION OF BATHYMETRY SURFACE

A 1 by 1 ft. grid of bathymetry elevations was required to convert depths below the sediment surface from the 1 mg/kg interpolator (see Section 3) to elevations. Ocean Surveys, Incorporated (OSI) conducted a bathymetric survey of East Rogers Island in July 2005 which included both multi-beam and single-beam data. OSI provided this data binned into a 1 by 1 ft. grid. However, this grid does not cover all of East Rogers Island; there are some gaps between grid cells and near the shoreline.

To fill in gaps, elevations (in NAVD88) were assigned to the GIS layer shoreline that was digitized from aerial photography of flow conditions in spring 2002. This Hudson River shoreline represents a flow rate of approximately 5,000 cfs at Fort Edward (QEA 2005) which corresponds to a flow rate of approximately 5216 cfs at Thompson Island Dam based upon tributary contributions (QEA 1999). It was assumed that at the shoreline, the water depth approaches zero which means the shore elevation is equal to the water surface elevation. The flow rate is linked to water-surface elevation by the equations below:

$$\text{At Fort Edward}: Elevation\,[ft] = 117.2 + 0.123 * (FlowRate[cfs])^{0.406} \qquad (2\text{-}1)$$

$$\text{At Thompson Island Dam}: Elevation[ft] = 117.2 + 0.062 * (FlowRate[cfs])^{0.441} \qquad (2\text{-}2)$$

The elevation of the shoreline between Fort Edward and Thompson Island Dam was approximated using linear interpolation. To calculate distance from Fort Edward, a Hudson River centerline was drawn. This line was divided into 10-ft. segments each with an associated distance to Fort Edward. The shoreline was converted into points and each point was assigned a distance from Fort Edward based on the distance associated with the closest Hudson River 10-ft. centerline segment.

A Triangulated Irregular Network (TIN; i.e., linear interpolation) of elevations was used to fill in gaps using both the bathymetry data from OSI and the approximate shoreline elevations. The gridded data from OSI and the filled in gaps were combined to create a complete grid of elevations.

SECTION 3
INTERPOLATION OF TOTAL PCB AT DEPTH

3.1 REVIEW OF IDW

Interpolations were performed to determine the areal extent of Total PCB concentrations at depth using the IDW deterministic interpolator with a specified optimization procedure. These interpolations are referred to as "1 mg/kg interpolations" because a Total PCB concentration of 1 mg/kg is the threshold that determines depth of contamination in a core. The steps involved in completing the 1 mg/kg interpolation are: 1) assigning Total PCB concentrations at depth; 2) transforming the assigned Total PCB concentrations; 3) delineating interpolation areas; 4) optimizing the IDW parameters; and 5) performing final IDW interpolation. Complete discussions of Steps 2 through 5 are available in Section 3 of the DAD Report. Only those aspects of each step pertinent to this particular analysis are discussed herein.

IDW was used rather than kriging because the data set was not amenable to the development of experimental variograms. The zero values in the data set, which constitute a significant portion at depth, tend to corrupt the variogram.

3.2 ASSIGNMENT OF TOTAL PCB AT DEPTH

The DAD Report categorized each available SSAP core with a CL, indicating the confidence in MPA estimations and in some cases, confidence in DoC. Further detailed discussion on CLs can be found in the DAD Report (QEA 2005). Each core with CL 1, 2A, 2B, 2C, 2D, 2E, 2F, 2G, 2H, 2J, 2K, or 2R was partitioned into 18 vertical slices at 2, 12, 24, 30, 36, 42, 48, 54, 60, 66, 72, 78, 84, 90, 96, 102, 108, and 114 inches. The length-weighted average Total PCB concentration for each slice was determined using the equation:

$$LWA = \sum_i \frac{TPCB_i(L_i)}{L_s} \qquad (3\text{-}1)$$

where: LWA is the length-weighted average of the Total PCB concentration of the slice, TPCB is the measured or extrapolated Total PCB concentration of section *i*, L is the length of the portion of section *i* that is greater than or equal to the top of the slice and less than or equal to the bottom of the slice, and L_s is the length of the slice.

Where appropriate, the straddle core protocol as defined in USEPA Final Decision (USEPA 2004, Appendix A) was used to calculate the Total PCB concentration in the portion above 12 in. of a core section whose top and bottom straddle 12 in. For cores that have a section straddling 12 in. (e.g., 2-24 in. section) and a Total PCB concentration in the section below the straddle section that is less than the straddle section, the Total PCB concentration in the portion of the straddle section above 12 in. was calculated assuming that all of the PCB mass in the straddle section was in that portion of the section. In these cases, correct mathematics requires that the Total PCB concentration in the portion of the straddle section below 12 in. be set to zero. To be conservative, this was not done. The Total PCB concentration below the 12 in. horizon was set equal to the measured concentration in the straddle section. This results in "double counting" of Total PCB concentrations. For example, if a 2-24 in. section had a Total PCB concentration of 10 mg/kg that was adjusted to 20 mg/kg using USEPA's equation for the 2-12 in. layer, the Total PCB concentration in the 12-24 in. layer was assumed to still be equal to 10 mg/kg.

In addition to the adjustments discussed above and data treatments discussed in Section 2.1, some special conditions were applied when assigning the slice Total PCB concentration values:

- Sections with Total PCB concentrations of non-detect were assigned concentrations of 0 mg/kg.
- Slices whose start depths were greater than or equal to the depth to the confining layer in CL 2C and 2R cores were assigned concentrations of 0 mg/kg. The confining layers in 2C and 2R cores are the clay and rock layers, respectively and were determined by reviewing the field notes of those cores. Slices in 2C and 2R cores where at least 25% of

the slice is deeper than the bottom of the last measured section and shallower than the confining layer were considered to have no data.

- Slices in CL 2H, 2J, and 2K cores whose start depths were above the depth of contamination were considered to have no data and those whose start depths were below the depth of contamination were assigned concentrations of 0 mg/kg.
- All final slice concentrations between 0 and 0.0001 mg/kg were assigned a value of 0 mg/kg in order to avoid complications in the data transformation.

If a slice did not meet any of the above criteria, did not include a straddle core section, included sections with measured or extrapolated concentrations, and included sections with no data, then the concentration of the slice was calculated as the LWA of the available concentrations.

3.3 INTERPOLATION AREAS

The Phase 1 Areas were divided into seven interpolation areas with approximately uniform flow direction. The division process was described in detail in the DAD Report, Section 3.2 (QEA 2005), and the interpolation areas used in this analysis are the same as the variogram areas used in the DAD Report, except RM192 was not included. In addition, East Rogers Island was divided into three different interpolation areas, as per USEPA's March 30, 2005 comments (see Section 2.2 of this Attachment). The interpolation areas are listed, along with the interpolation area flow direction, in Table D-3-1 and shown in Figure D-3-1. Interpolations were carried out separately for each slice in each interpolation area.

Table D-3-1. Interpolation areas for Phase 1 intermediate design and related flow direction.

Subarea	Flow Direction (degrees)
West_RI	150
East_RIa	100
East_RIb	165
East_RIc	40
Lock7	35
NE_GI	170
SE_GI	20

3.4 TRANSFORMATION OF SLICE LWA TOTAL PCB CONCENTRATIONS

The Total PCB concentration of each slice in each core was transformed using the same procedure as in the DAD Report: the Box-Cox transformation was applied in order to arrive at an optimal λ value that generally resulted in a distribution visually closest to linear on a normal probability scale. Normality was evaluated using the Shapiro-Wilk Test. The Box-Cox transformation and Shapiro-Wilk Test are described in detail in the DAD Report (Section 3.3, QEA 2005).

3.5 OPTIMIZATIONS

Using a similar procedure as described in the DAD Report (QEA 2005), the IDW parameters were optimized in an effort to minimize errors. Each layer was optimized independently, around the decision criterion of 1 mg/kg (i.e., the accuracy of the model in predicting whether the point is above or below 1 mg/kg). The parameters that were optimized were:

1. azimuth;
2. IDW power;
3. major semiaxis; and
4. anisotropy ratio.

Optimization was performed using a computer program written in Interactive Data Language (IDL; a programming environment for statistical and graphical data analysis; www.rsinc.com/idl/) and is described in detail in the DAD Report (Section 3.4.1.3, QEA 2005). The optimized parameters were chosen, primarily, to minimize the Type 2 errors (false negatives) with a secondary priority of minimizing total errors. The optimized IDW parameters for the 18 slices in the six Phase 1 variogram areas are summarized in the Tables D-3-2, D-3-3, and D-3-4. A table for azimuth is not included because that parameter is the flow direction in the given variogram area (Table D-3-1).

Table D-3-2. Optimized anisotropy for 1 mg/kg interpolation.

Subarea	0 to 2 in.	2 to 12 in.	12 to 24 in.	24 to 30 in.	30 to 36 in.	36 to 42 in.	42 to 48 in.	48 to 54 in.	54 to 60 in.	60 to 66 in.	66 to 72 in.	72 to 78 in.	78 to 84 in.	84 to 90 in.	90 to 96 in.	96 to 102 in.	102 to 108 in.	108 to 114 in.
West_RI	5	5	5	2	2.9	2.5	2	2	2	2	2	2	2	2	2	2	2	2
East_RIa	5	2	10	1.5	1.5	2	2	2	2	2	2	2	2	2	2	2	2	2
East_RIb	7	2.5	2.5	7	10	2	2.5	2	2	2.9	2	2	2	2	2	2	2	2
East_RIc	2	5	5	5	5	5	2	2	2	2	2	2.9	2	3	2	2	2	2
Lock7	2.5	1	1.5	2.5	2.9	2	1.5	2	2	2.5	2	2	2.5	2	2	2	2	2
NE_GI	5	1.5	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
SE_GI	3	2	2.5	2.9	2	2.5	2.9	2.9	2	2	2.9	2	2	2	2	2	2	2

Table D-3-3. Optimized major semiaxis for 1 mg/kg interpolation.

Subarea	0 to 2 in.	2 to 12 in.	12 to 24 in.	24 to 30 in.	30 to 36 in.	36 to 42 in.	42 to 48 in.	48 to 54 in.	54 to 60 in.	60 to 66 in.	66 to 72 in.	72 to 78 in.	78 to 84 in.	84 to 90 in.	90 to 96 in.	96 to 102 in.	102 to 108 in.	108 to 114 in.
West_RI	540	540	540	200	310	310	200	200	200	200	200	200	200	200	200	200	200	200
East_RIa	540	200	1000	140	140	200	200	200	200	200	200	200	200	200	200	200	200	200
East_RIb	770	1000	540	770	1000	200	310	200	200	310	200	200	200	200	200	200	200	200
East_RIc	200	540	540	540	540	540	310	200	200	200	200	310	200	540	200	200	200	200
Lock7	770	540	890	310	1000	200	140	200	200	540	200	200	310	200	200	200	200	200
NE_GI	540	1000	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200
SE_GI	540	770	540	310	200	540	310	310	200	200	310	200	200	200	200	200	200	200

Table D-3-4. Optimized power for 1 mg/kg interpolation.

Subarea	0 to 2 in.	2 to 12 in.	12 to 24 in.	24 to 30 in.	30 to 36 in.	36 to 42 in.	42 to 48 in.	48 to 54 in.	54 to 60 in.	60 to 66 in.	66 to 72 in.	72 to 78 in.	78 to 84 in.	84 to 90 in.	90 to 96 in.	96 to 102 in.	102 to 108 in.	108 to 114 in.
West_RI	2.5	1.5	5	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
East_RIa	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
East_RIb	1	1.5	2.5	3	4.5	4.5	5	3.5	4	1	1	1	1.5	1.5	1	1	1	1
East_RIc	1	1	2.5	1.5	4	1	3.5	1	1	1	1	1	1	2	1.5	1	1	1
Lock7	1	1	3	5	3.5	5	5	4.5	1	3.5	1	1	1	1	1	1	1	1
NE_GI	3	1	3.5	2.5	1	1	1	1	1	1	1	1	1	1	1	1	1	1
SE_GI	1	1	5	3.5	1	4	1	1	1	1	5	1	1	1	1	1	1	1

3.6 FINAL INTERPOLATION PARAMETERS AND RESULTS

Interpolations were performed in each interpolation area for each of the 18 slices. The grid cells within the interpolation area were then assigned depth values equal to the bottom of the deepest slice for which the interpolated Total PCB concentration value was greater than or equal to 1 mg/kg. This grid is the dredge depth surface as defined by the IDW interpolator. The final interpolated surfaces showing the depth at which Total PCB concentrations go below 1 mg/kg are presented in Figures D-3-2a through D-3-2c.

SECTION 4
DEVELOPMENT OF ELEVATION OF CLAY SURFACE

4.1 ASSIGNMENT OF ELEVATION OF DATA POINTS

Both SSAP cores and SEDC borings were assigned elevations based on the 1 by 1 ft. grid of July 2005 multi-beam bathymetry data provided by OSI. Each core was assigned an elevation from the nearest bathymetry grid cell. In addition, statistics on all bathymetry grid cells within 1.6 ft. of each core were examined to check that core elevations were not influenced by features such as fallen trees or debris.

4.2 DEVELOPMENT OF ELEVATION OF CLAY SURFACE

The following steps were used to develop the elevation of clay surface: 1) determine the depth to clay at each core; 2) convert the depths to elevations; 3) manually draw 5-ft. clay surface contours based on clay elevations and the elevations of the bottom of cores where the clay is not present; 4) create 1-ft. clay surface contours based upon TINs; 5) manually adjust the 1-ft. contours; and 6) create a surface based upon the 1-ft. contours.

The depth to Glacial Lake Albany clay in each core is determined as described in Section 2.3. The elevation of clay layer was calculated by subtracting the depth to clay from the elevation assigned to the core. Next, 5-ft. contours of the top of clay were hand-drawn based on clay elevations and the bottom elevation of cores without clay. In locations where there are cores without clay, the elevation of the clay surface must be deeper than or equal to the bottom elevation of these cores.

One-foot top of clay contours were then created by creating two TINs. The first TIN is based upon the 5-ft. contours and the clay elevations from cores with Glacial Lake Albany clay. The second TIN is based upon all the information used in the first TIN and the bottom elevation of cores without clay. These two TINs were converted into 1 by 1 ft. grids. One-foot contours were created from the minimum value of the two grids based upon TINs and the bathymetry data. This ensures that the top of clay surface honors cores with clay and cores without clay, and does not exceed the elevation of the river bottom bathymetry. The 1-ft. contours were manually adjusted, as necessary, and a TIN was created based only upon these 1-ft. contours. A grid was created from the TIN and if the elevation of any grid cells exceed the elevation of the river bottom bathymetry, the elevation of these grid cells was set equal to the bathymetry elevation. This clay elevation grid was then converted to a point GIS file to be used in the next step in defining the dredge surface. The final surface showing the elevation of clay in East Rogers Island is presented in Figure D-4-1.

4.3 DEVELOPMENT OF AREA WHERE CLAY SURFACE GOVERNS DOC

Areas in which the top of clay appeared to define the DoC were delineated by plotting the difference between the DoC and the depth to clay for each individual location. Figure D-4-2 shows the data from the east side of Rogers Island. If the DoC is equal to the depth to clay the location is shown as a pink colored dot; cores where the DoC is above the clay are colored red, and locations where the DoC extends into the clay are colored blue. From these data, the areas where the DoC appears to coincide with the top of clay were delineated. A weight of evidence approach was used to establish these areas. In general, cores that had the DoC 2 in. or less above the top of the clay layer were included in the "clay areas". The clay areas were not extrapolated to the shoreline because the near shore areas likely have been depositional since before PCB usage and would contain clean sediments on top of the clay surface. Figure D-4-3a and Figure D-4-3b show the areas where the clay layer was used to establish the DoC over the entire Phase 1 Area of the river.

SECTION 5
DEVELOPMENT OF FINAL DOC SURFACE

5.1 TRANSFORMATION OF 1 mg/kg INTERPOLATION RESULTS TO ELEVATIONS

As discussed in Section 3.6, the 1 mg/kg interpolation results assign a depth of dredging to each 10 by 10 ft. grid cell. In order to define a dredge surface it was necessary to convert these 10 ft. grid cells into 1 ft. grid cells and convert depths to elevations. The 10 ft. grid cells were converted to 1 ft. grid cells using a TIN. These 1 ft. grid cells were then converted to elevations by subtracting the 1 mg/kg interpolation grid from the bathymetry grid provided by OSI (see Section 2.4 of this Attachment). Each 1 ft. square grid cell in the 1 mg/kg interpolation grid was aligned with the corresponding bathymetry cell and the depth was subtracted from the elevation resulting in a new "1 mg/kg elevation" grid. The 1 mg/kg elevation grid was then converted to a GIS point file to be used in the next step in defining the dredge surface. Each point of the 1 mg/kg elevation point shapefile was geographically located at the center point of each grid cell and the value of the point was the elevation of the cell.

5.2 COMBINING OF INTERPOLATION WITH ELEVATION OF CLAY INFORMATION

The 1 mg/kg elevation point shapefile was combined with the clay elevation point file in order to define the final dredge surface. The areas where the clay surface governs DoC, which is described in Section 4.3, were used to query out the points in the clay elevation point file with these areas and the points in the 1 mg/kg elevation point file outside of these areas. The results of these two queries were merged together to create a 'married' point file. The final surface for East Rogers Island is shown in Figure D-5-1.

SECTION 6
CROSS-VALIDATION OF FINAL RESULTS

6.1 BACKGROUND

On May 20, 2005, GE received a memo from USEPA, detailing suggested elements of for the Phase 1 Intermediate Design Report (Kern 2005). The memo details uncertainties in determining the depth of dredging and argues for cross validation and statistical testing of any proposed depth of contamination method. Pursuant to the recommendations of this memo, a cross-validation of the 1 mg/kg interpolator was conducted and is reported below. It should be noted that a number of the statistics that are recommended by Kern (2005) as a measure of the methods performance require a set "decision criteria" (e.g., sensitivity, specificity, false positives [Type 1 errors], and false negatives [Type 2 errors]). However, there are no set decision criteria for DoC and these statistics are not calculable for the final surface. Although the statistics could be calculated for each layer around 1 mg/kg, it was felt that this level of effort (there are 18 layers in the 1 mg/kg interpolation) is unwarranted. Instead, statistical measures that were calculable are presented below with plots and other analyses documenting the performance of the method.

Kern (2005) also stated that the uncertainty of the estimated DoC surface "...should be evaluated quantitatively to provide EPA with the estimates of the likelihood of success and the range of potential outcomes of the remedial performance" and suggested the following be calculated:

- projected re-dredging rate;
- proportion of inventory expected to remain in place;
- proportion of remediated sediment expected to be below criteria;
- uncertainty in total volume estimates;
- percentage of certification units expected to fail the residual standard; and
- implications to projected schedule.

As indicated above, GE believes that the uncertainty derived from kriging cannot be used to infer the true uncertainty of the DoC surface so that the bulleted information above can be calculated with confidence. Furthermore, the uncertainty of the DoC surface is influenced by data quality issues that tend to force overestimates of the DoC. These issues are discussed in Section 3.4.2.2 of the Intermediate Design Report and include: 1) a high bias of the PCB analytical results; 2) downward mixing of PCBs due to the coarse sectioning of cores; 3) downward smearing of contaminated sediments as a core tube is pushed through the sediments; and 4) use of a conservative equation to extrapolate PCB concentrations downward for incomplete cores. Moreover, uncertainty in the DoC surface is not the only factor contributing to the need for redredging. Imperfect bottom coverage by the dredge, sloughing of sediments at the edges of the dredge prism, fallback of sediments disturbed but not captured by the dredge, and the presence in some places of a rough hard bottom all contribute to the need for redredging. Consequently, GE has not attempted to calculate the information in the bulleted list. It is GE's view that such an attempt would be meaningless and the only reasonable way to obtain this information is through the Phase 1 dredging program. The data obtained in Phase 1 will allow an assessment of the uncertainty associated with the data and modeling used to establish the DoC surface that can be used to make inferences for Phase 2 dredging that can be used to refine the approach to DoC estimation to the extent that the applied approach is inadequate for design.

6.2 CROSS-VALIDATION METHODS APPLIED

For the 1 mg/kg interpolator, a leave-one-out cross-validation was performed. One point was removed from the data set and the remaining data points were used to predict total PCB concentrations in each layer at the removed point's location. This information was used to compare predicted dredge depth (the bottom of the deepest layer with a predicted total PCB concentration greater than or equal to 1 mg/kg) with measured DoC. Differences in predicted and measured DoC were quantified using root mean squared error (RMSE), mean error (ME), and mean absolute error (MAE) as calculated by the equations below.

$$RMSE = \sqrt{\frac{\sum_{n}(predicted - measured)^2}{n}} \tag{6-1}$$

$$ME = \frac{\sum_{n}(predicted - measured)}{n} \tag{6-2}$$

$$MAE = \frac{\sum_{n}(|predicted - measured|)}{n} \tag{6-3}$$

6.3 CROSS-VALIDATION RESULTS FOR EAST ROGERS ISLAND

The East Rogers Island area is characterized by widely varying DoC and poor spatial correlation. Cores (excluding CL2D cores) spaced at less than about 40 ft. apart have differences in DoC that range from zero to 16 inches and at some locations individual cores have DoC values that are radically different from neighboring cores about 80 to 160 ft. away. For example, at the point where the East Rogers Island channel bends to the west, a single location with deep DoC (extrapolated depth on the order of 100 inches) confirmed by data gap sampling is surrounded by cores with DoC of 48 inches or less. This variability is not well described by mathematical interpolation and the interpolated DoC surface likely is the least accurate in this area of the river.

Cross validation results for the 1 mg/kg interpolator are presented for the portion of East Rogers Island that is oriented North-South, starting north of the Bond Creek confluence and ending just before the channel turns to the southwest (see Figure D-3-1). This portion contains the bulk of the data and provides the best ability to compare measured and predicted DoC values. Figure D-6-1 presents the results in two ways. The left panel in the figure shows a cross-plot of predicted DoC from the 1 mg/kg interpolator and measured DoC (i.e., DoC as determined from core information, including extrapolations). The different symbols on the left hand plot indicate whether the core is CL1 (complete) or CL2 (extrapolated) and the different colors indicate whether the core is located in an area that will be governed by the 1 mg/kg interpolator (red) or the elevation of Glacial Lake Albany clay (blue). The right panel shows the distribution of differences between predicted and measured DoC for each of the predicted DoC increments. The left panel indicates that there is significant variability in the ability to predict DoC at locations where data have been removed from the interpolation. The right panel shows that the model does a reasonable job on average. The horizontal bars in the center of each rectangle indicate the median difference between the predicted and measured DoC values. In most of the depth increments, the median is close to zero. The variability is large with the range of 75% of the data (indicted by the limits of the rectangles) extending about +/-10 inches for predicted DoCs up to 24 inches and slightly larger for greater predicted DoCs. This characterization of the comparison is supported by the error statistics. The mean error is essentially zero, whereas the mean absolute error is about 14 inches and the root mean square error is about 20 inches. Further information is provided in a statistical summary of the cross validation that is presented in Table D-6-1. This table shows that the median measured DoC at a predicted DoC about equals the predicted DoC but that the maximum and minimum measured values are much different from that predicted by the model. In cases where the difference between the measured and predicted DoC values is large, the core removed from the data set tends to have a DoC that is much different from the values of surrounding cores on which the interpolator relies to predict the DoC at the location of the removed core. In addition, the majority of the underpredictions from the 1 ppm interpolator occur with CL2 cores. This may be an indication of the conservative nature of the extrapolation technique, as discussed in the Phase 1 DAD (QEA 2005).

Table D-6-1. Statistics on measured DoC for each predicted DoC value in East_RIb.

Predicted DoC (inches)	Measured DoC (inches)				
	Number of cores	Minimum	Maximum	Median	Mean
2	9	0	24	3	6
12	20	0	36	12	11
24	25	2	106	30	32
30	20	0	68	24	28
36	9	2	54	24	24
42	10	8	57	42	38
54	3	30	69	56	52
78	1	36	36	36	36
102	1	48	48	48	48

Notes:
Confidence level 2D cores are not included.
All predicted values in this table are based on the 1 mg/kg interpolator, even in dredge to clay areas.

The cross validation provides some sense of the uncertainty of the interpolated DoC surface but it probably overestimates uncertainty since, by removing a core from the data set, it looks at the uncertainty of predicting DoC at distances of 80 ft. from the nearest core, whereas the interpolated surface relies on interpolations at distances of 40 ft. from the nearest core. Nonetheless, cross-validation demonstrates the weakness of the interpolator as a predictive tool. The conservative nature of the measured DoCs and the ability to use Glacial Lake Albany clay as a DoC marker in some areas of the river compensate for this weakness, but the interpolated DoC surface must be used with care, ensuring that dredge prisms are revised as necessary to account for data at variance with the interpolator results (see Step 8 of the Dredge Prism Development Process presented in the Phase 1 Intermediate Design Report). In the absence of significant and stationary spatial correlation, the data themselves provide the only reliable means available to characterize DoC. Mean errors from cross validation or some central tendency characterization of the variability in DoC among closely spaced cores do not provide reasonable estimates of the uncertainty of individual DoC measurements or the interpolated DoC values in between those measurements. This conclusion applies throughout the Phase 1 Areas. Although the East Rogers Island area is the most difficult within which to characterize DoC, the concerns with the predictive ability of interpolation extend through all the dredge areas.

SECTION 7
REFERENCES

Blasland, Bouck & Lee, Inc., 2003. *Remedial Design Work Plan*. Prepared for General Electric Company.

Cadwell, Donald, 2005. Personal communication with L. Scheuing. Glens Falls, NY, June 30, 2005.

Kern, John, 2005. Suggested elements for inclusion in Phase-I Intermediate Design Report. Memo to Claire Hunt, April 8, 2005.

QEA, 2005. *Phase 1 Dredge Area Delineation*. Prepared for General Electric Company.

QEA, 2003. *Design Support Sediment Sampling and Analysis Program, Supplemental Field Sampling Plan*. Prepared for General Electric Company.

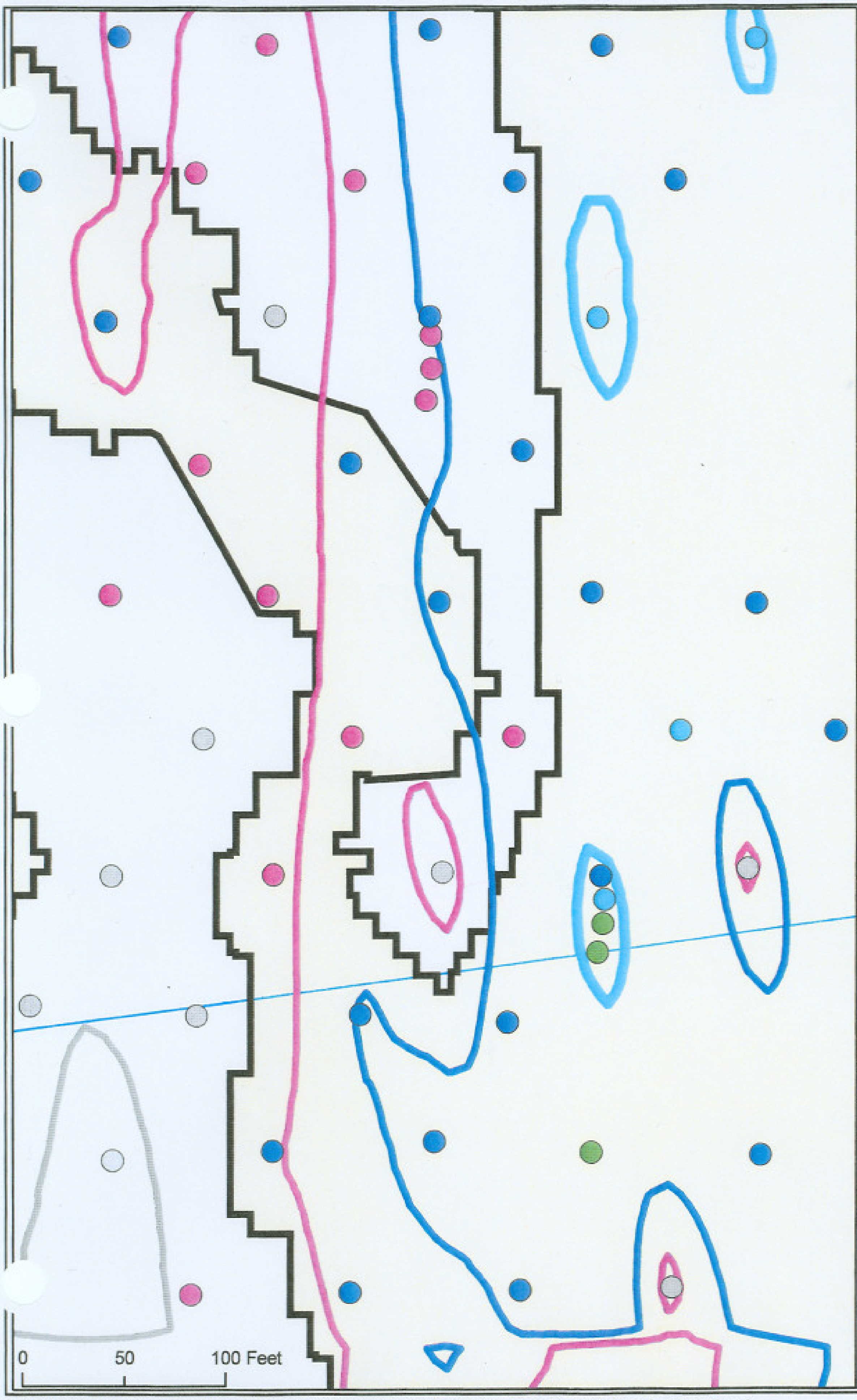
QEA, 2002. *Design Support Sediment Sampling and Analysis Program, Supplemental Field Sampling Plan*. Prepared for General Electric Company.

QEA, 1999. *PCBs in the Upper Hudson River - Volume 2: A Model of PCB Fate, Transport, and Bioaccumulation*. Prepared for General Electric Company.

U.S. Environmental Protection Agency, 2004. *Resolution of GE Disputed Issues since GE's May 21, 2004 Presentation to the Regional Administrator*. July 22, 2004.

FIGURES

Quantitative Environmental Analysis, LLC



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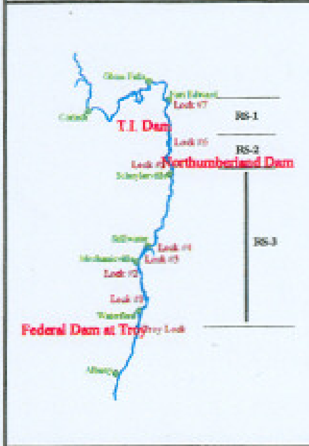

LEGEND

- River Miles
- Shore Line
- Dams and Locks
- Dredge Areas

- DOC = 0 - 2
- DOC = 2 - 12 in.
- DOC = 12 - 24 in.
- DOC = 24 - 30 in.
- DOC = 30 - 36 in.
- DOC = 36 - 42 in.
- DOC = 42 - 48 in.
- DOC = 48 - 54 in.
- DOC = 54 - 60 in.
- DOC = 66 - 85 in.
- DOC = 85 - 96 in.
- DOC = 96 - 102 in.
- DOC = 96 - 102
- DOC = 102 - 108

Contours

- DOC = 2 in.
- DOC = 12 in.
- DOC = 16 in.
- DOC = 24 in.
- DOC = 30 in.

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Figure D-1-1.

50th percentile results of kriging DoC from Phase 1 DAD in the vicinity of the Griffin Island and associated data, indicating discontinuity in DoC data.

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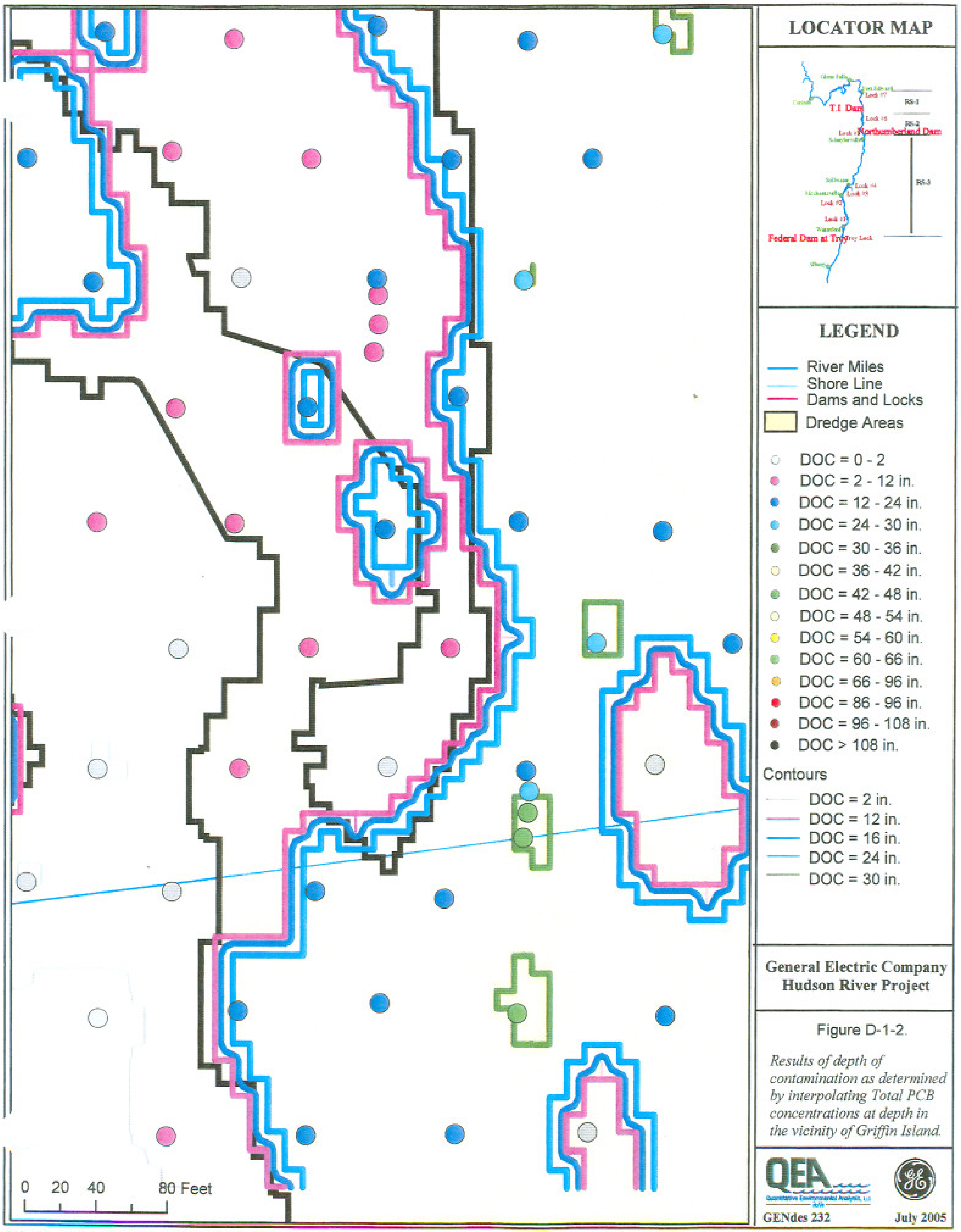

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Figure D-1-2.

Results of depth of contamination as determined by interpolating Total PCB concentrations at depth in the vicinity of Griffin Island.

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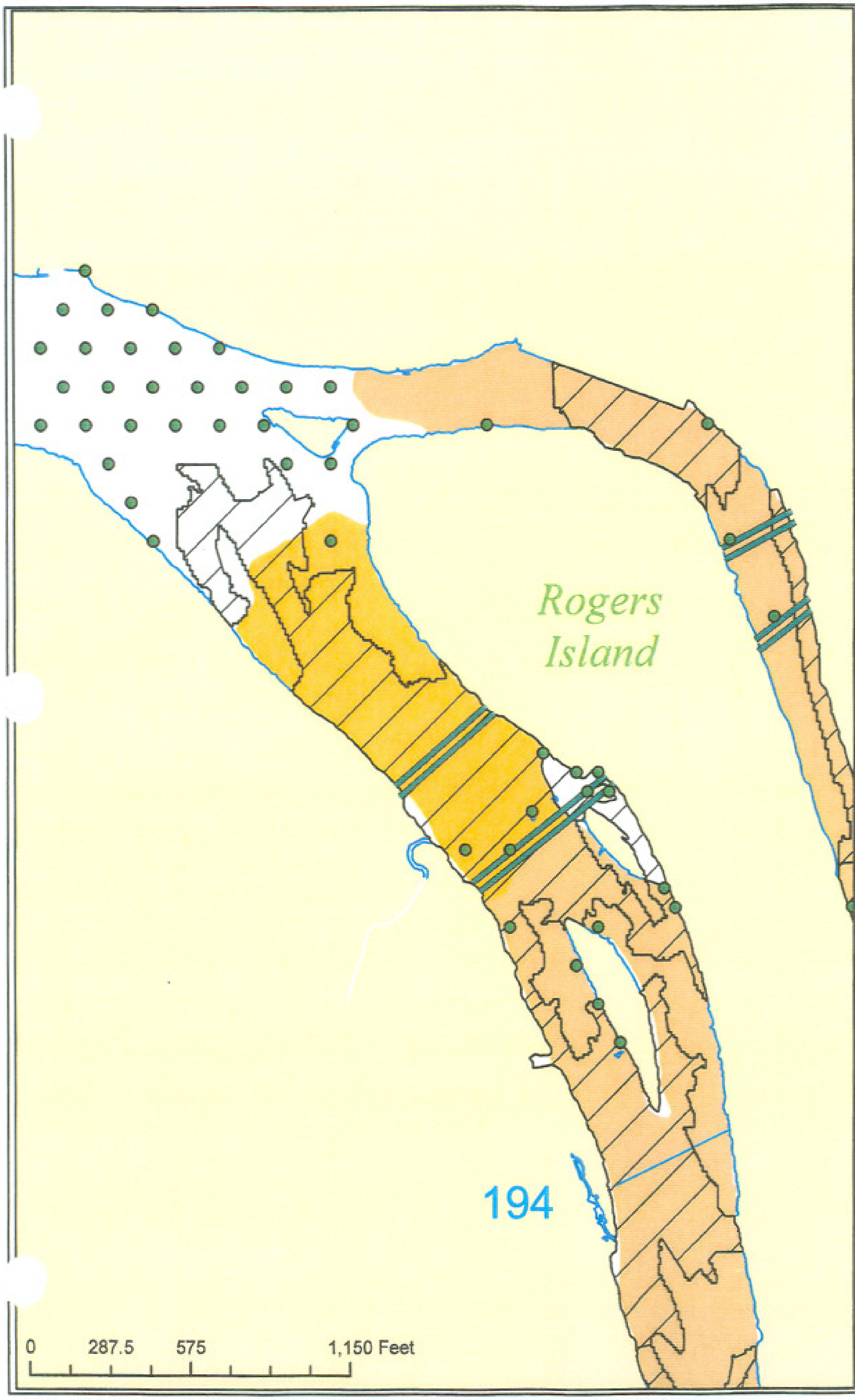

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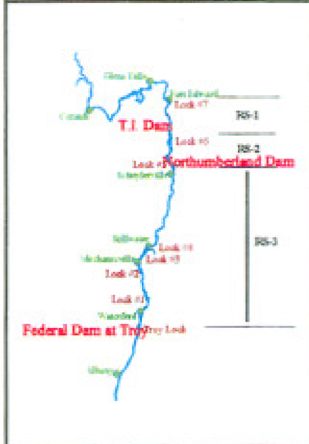

LEGEND

- River Miles
- Shore Line
- Dams and Locks
- Bridges
- Inaccessible areas
- Dredge Areas
- Type I sediment
- Type II sediment
- Type III sediment
- Type IV sediment
- Type V sediment

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Figure D-2-1.

Inaccessible locations in Northern West Rogers Island

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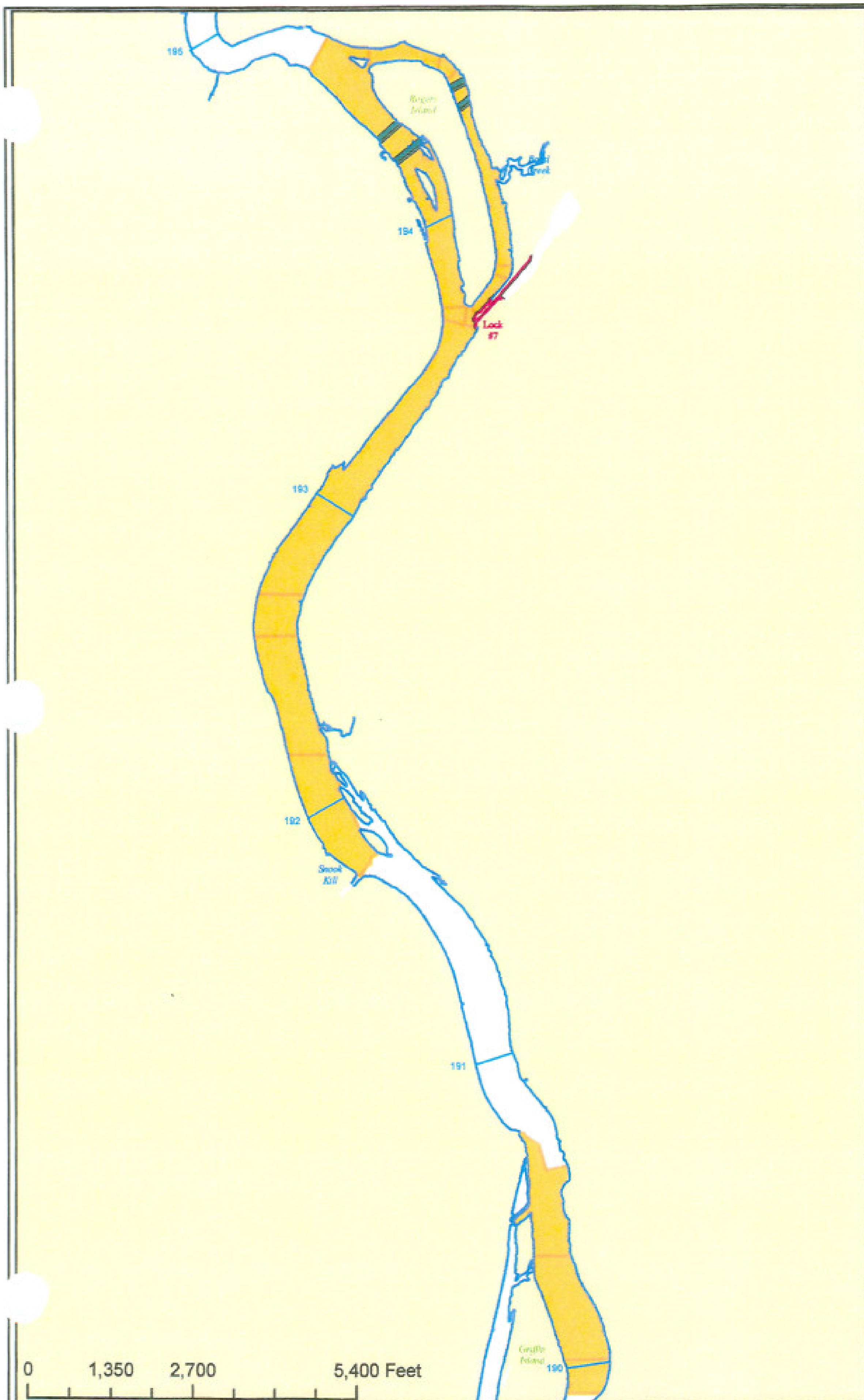

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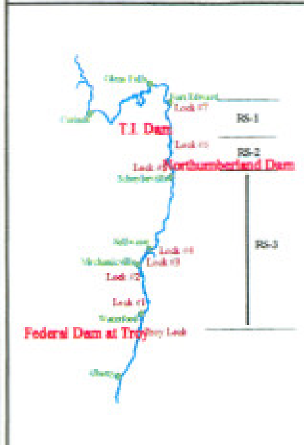

LEGEND

- River Miles
- Shore Line
- Dams and Locks
- Bridges
- IDW interpolation areas

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Figure D-3-1.

Interpolation areas for Phase 1 Areas used for interpolation of Total PCB concentrations at depth.

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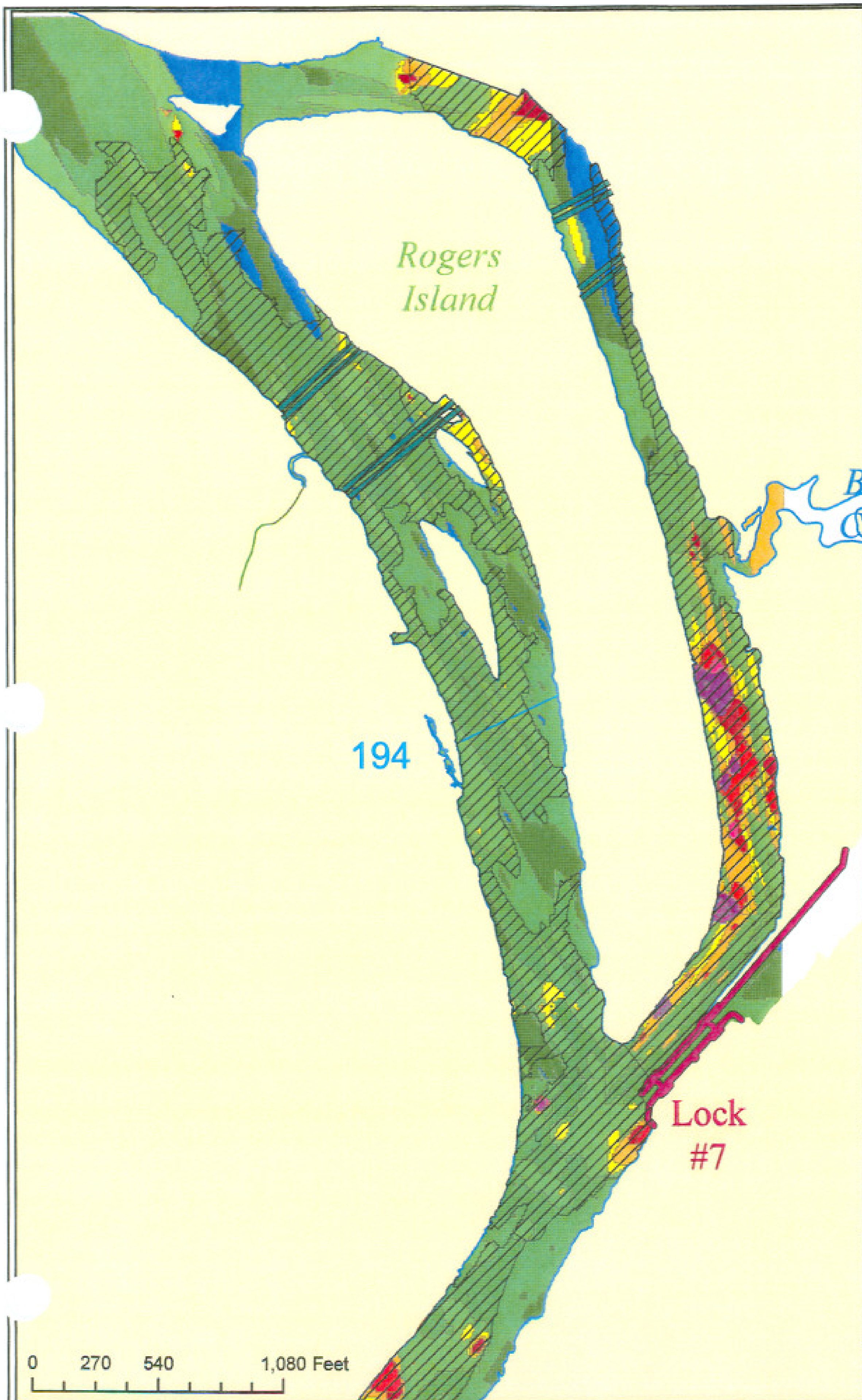

LOCATOR MAP

LEGEND

- River Miles
- Shore Line
- Dams and Locks
- Bridges
- Dredge Areas
- DoC = 0 in.
- DoC = 2 in.
- DoC = 12 in.
- DoC = 24 in.
- DoC = 30 in.
- DoC = 36 in.
- DoC = 42 in.
- DoC = 48 in.
- DoC = 54 in.
- DoC = 60 in.
- > 60 in. DoC

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Figure D-3-2a.

Results of the interpolations of Total PCB concentrations at depth for East and West Rogers Island.

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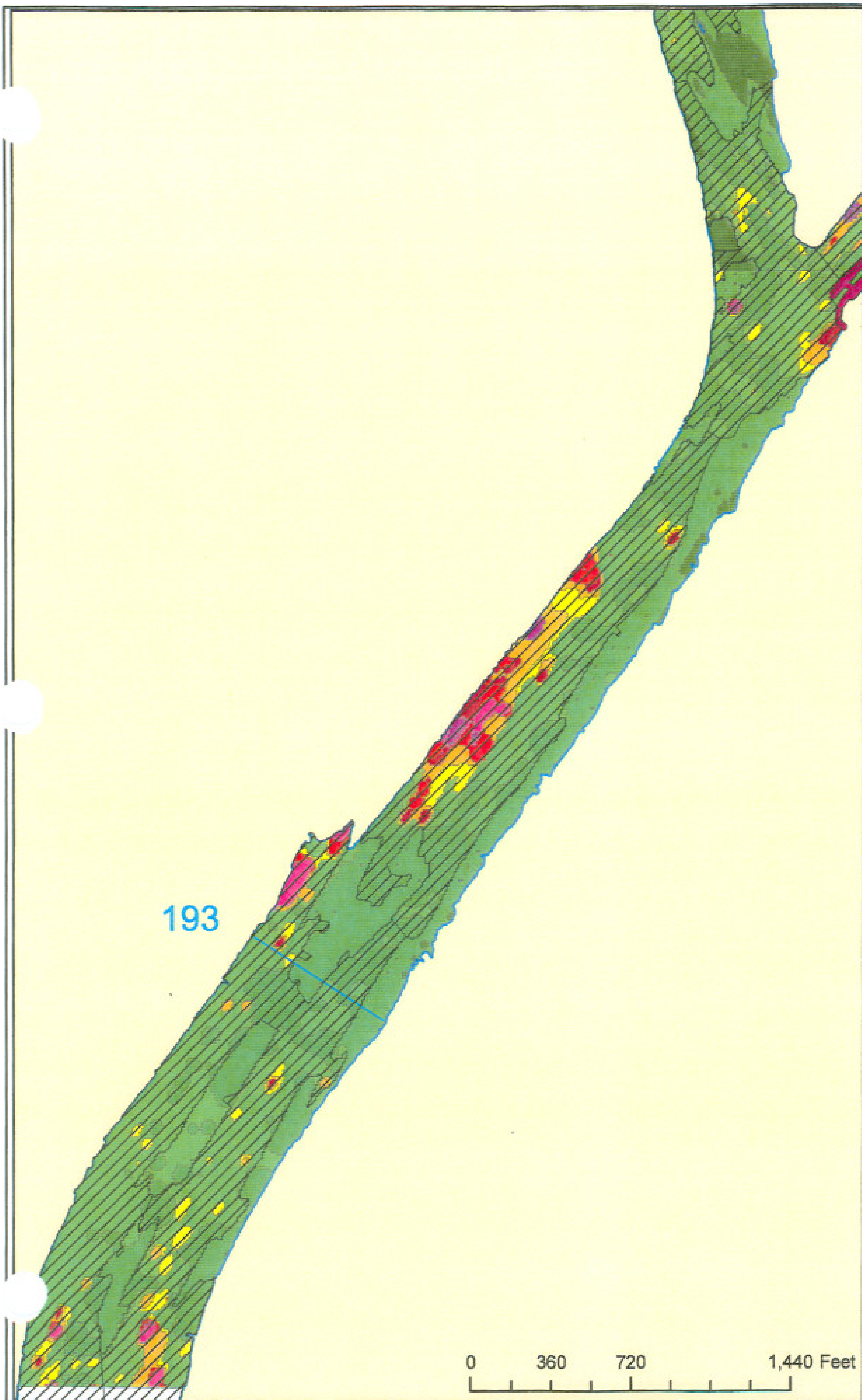

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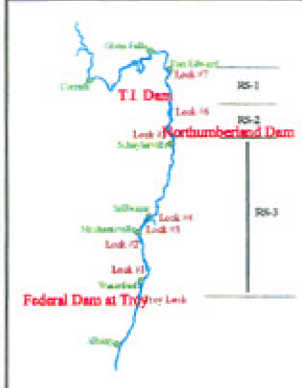

LEGEND

- River Miles
- Shore Line
- Dams and Locks
- Bridges
- Dredge Areas
- DoC = 0 in.
- DoC = 2 in.
- DoC = 12 in.
- DoC = 24 in.
- DoC = 30 in.
- DoC = 36 in.
- DoC = 42 in.
- DoC = 48 in.
- DoC = 54 in.
- DoC = 60 in.
- > 60 in. DoC

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Figure D-3-2b.

Results of the interpolations of Total PCB concentrations at depth for the Lock 7 area.

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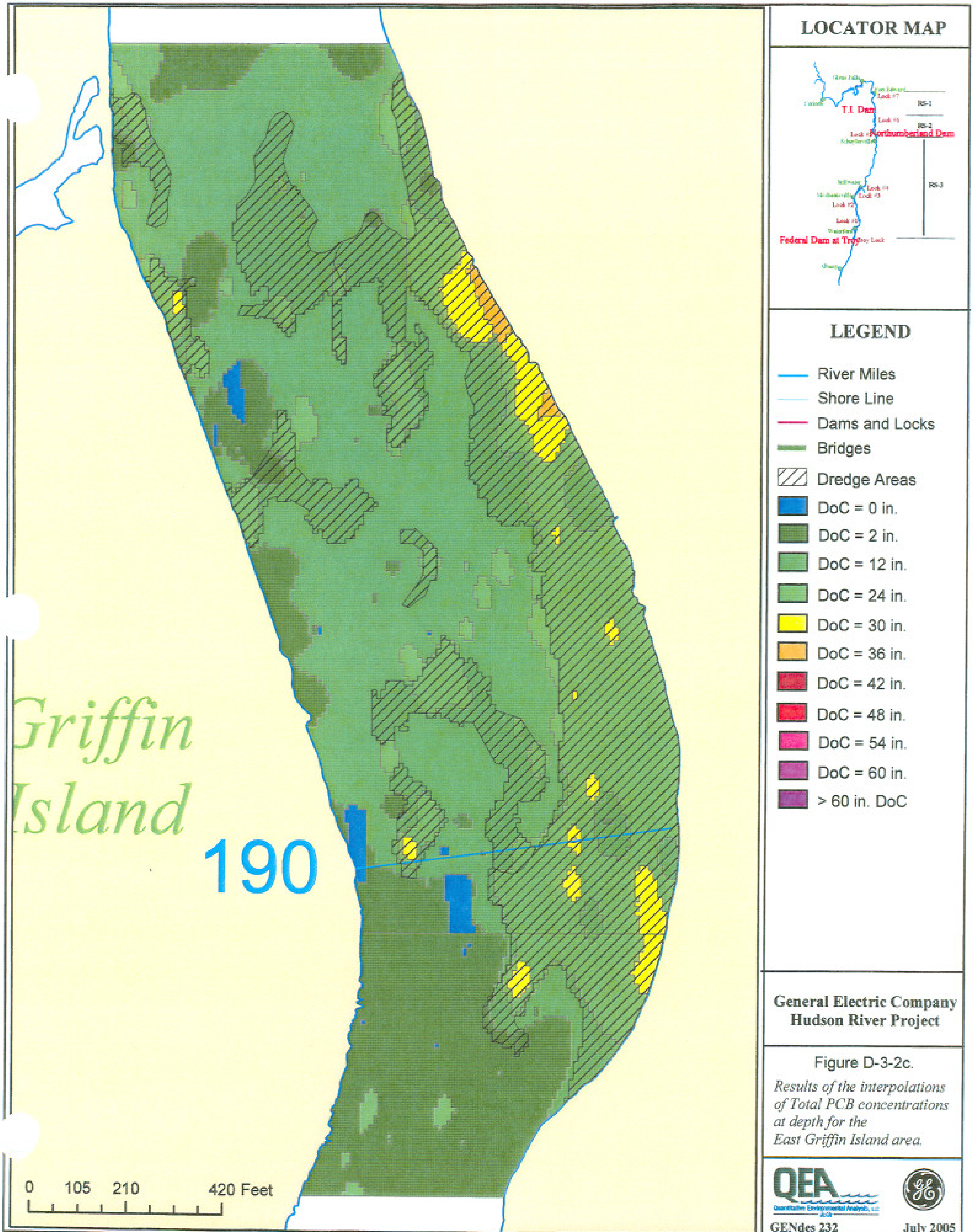

Figure D-3-2c.

Results of the interpolations of Total PCB concentrations at depth for the East Griffin Island area.

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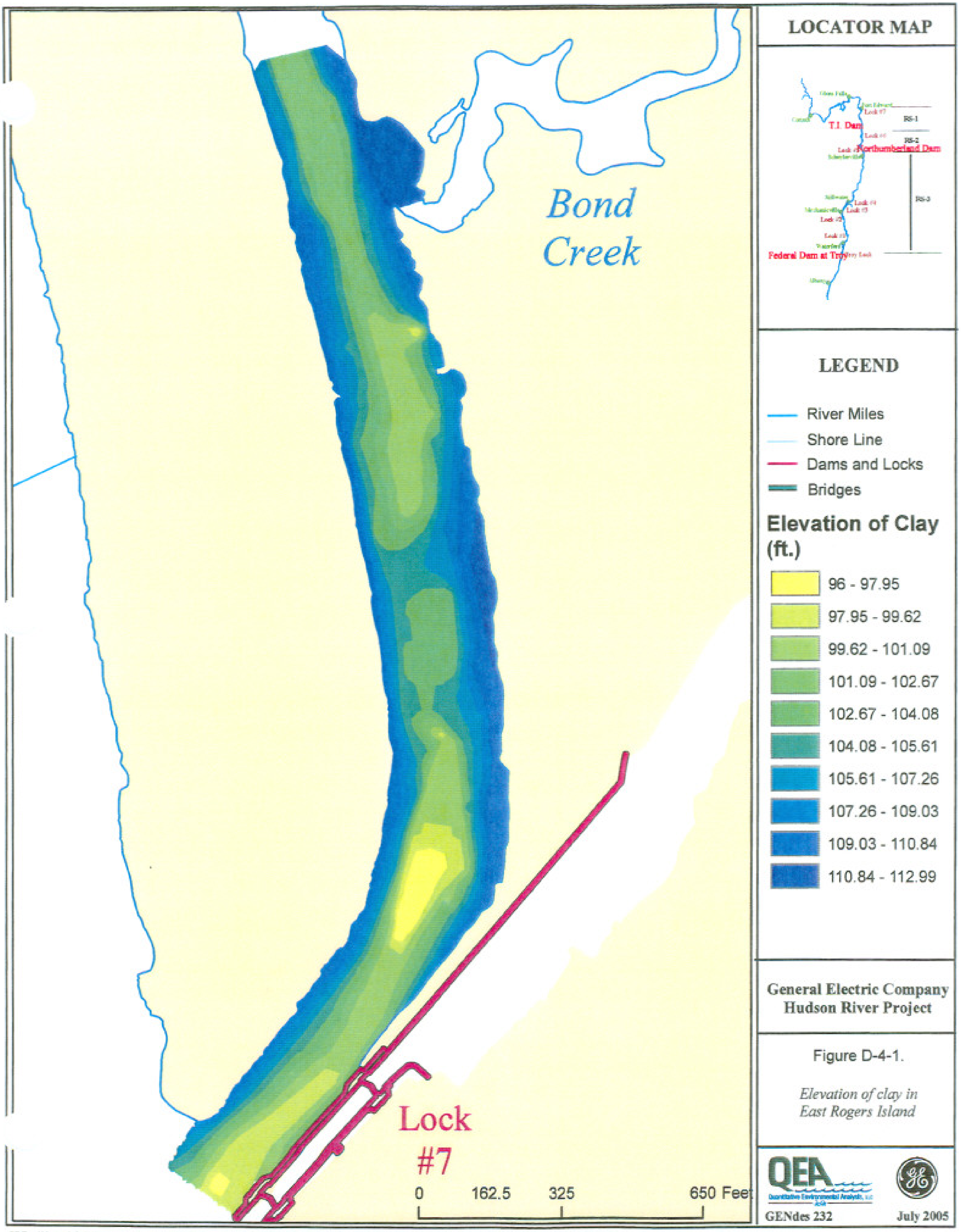

Figure D-4-1.

Elevation of clay in East Rogers Island

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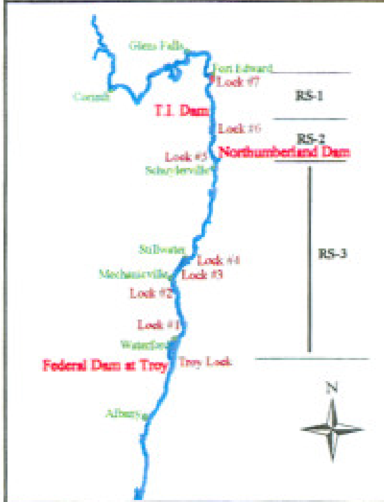
LOCATOR MAP OF THE UPPER HUDSON RIVER



GRAPHIC SCALE

0 150 300 Feet

LEGEND

- DoC extends into the clay layer
- DoC and clay are at the same depth
- DoC is shallower than the top of clay layer
- Dredge to Clay Area

Figure D-4-2

Comparison of Depth to Clay and DoC in East Rogers Island

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Aug 17, 2005

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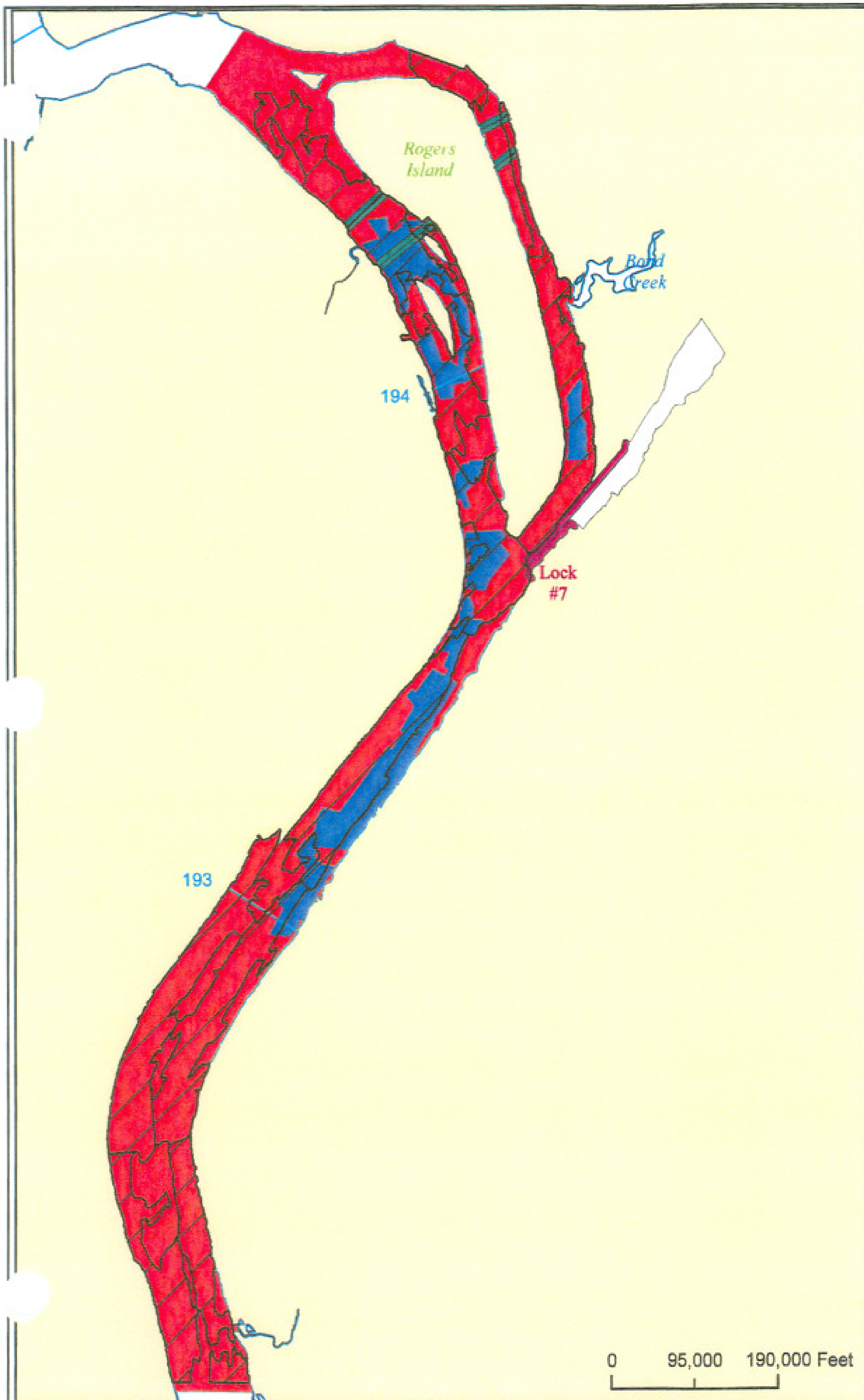

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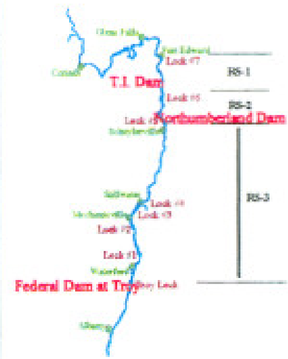

LEGEND

- River Miles
- Shore Line
- Dams and Locks
- Bridges
- Dredge Areas
- Clay areas
- 1ppm areas

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Figure D-4-3a.

Dredge to clay and dredge to 1 mg/kg areas.

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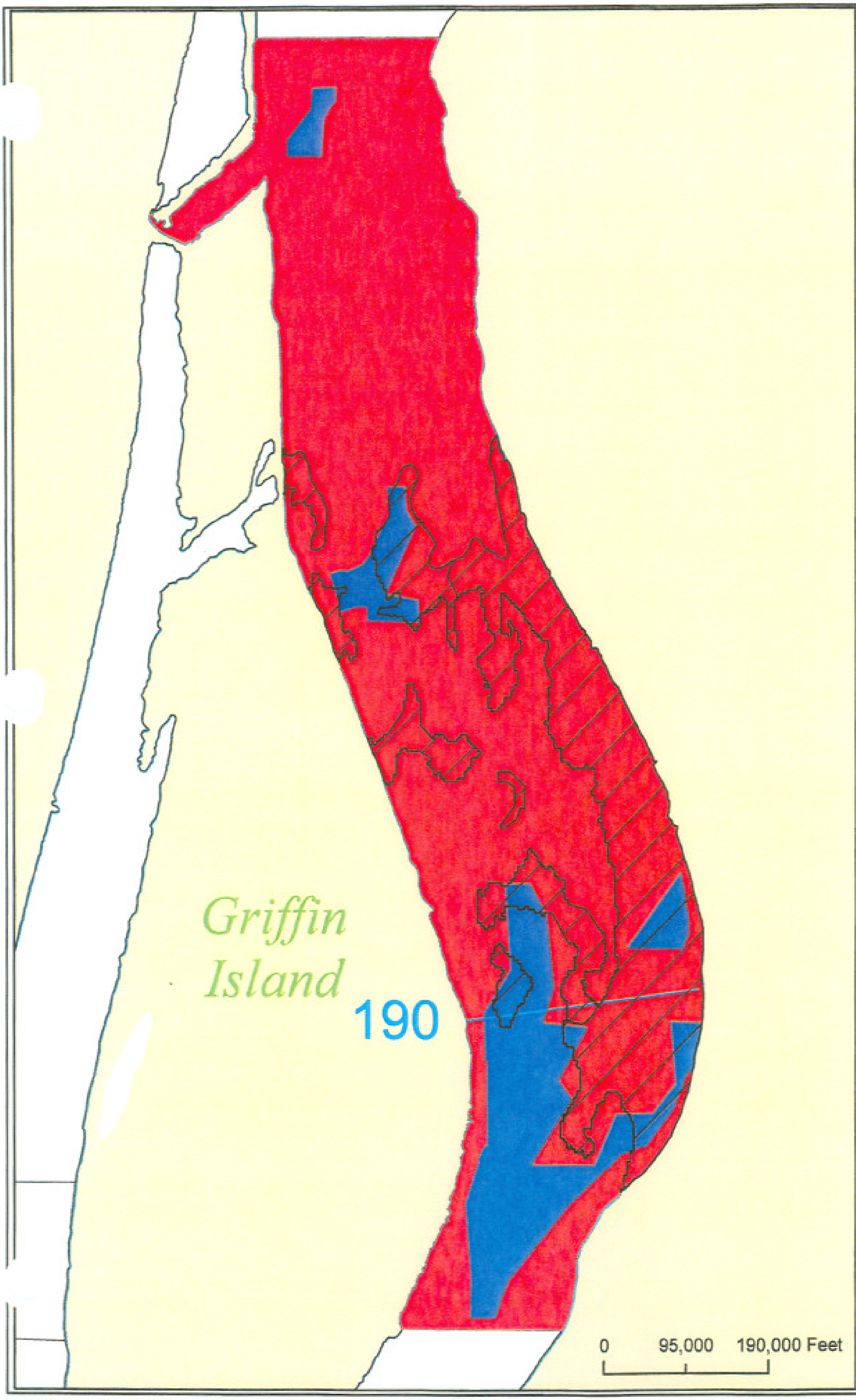
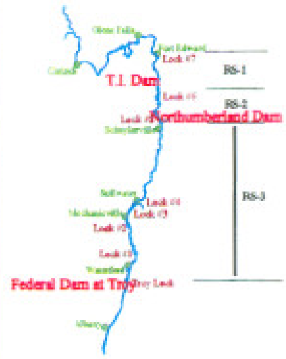


LOCATOR MAP



LEGEND

- River Miles
- Shore Line
- Dams and Locks
- Bridges
- Dredge Areas
- Clay areas
- 1ppm areas

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Figure D-4-3b.

Dredge to clay and dredge to 1 mg/kg areas.

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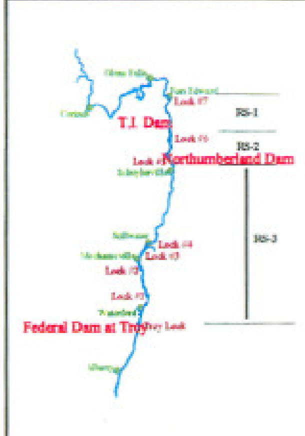
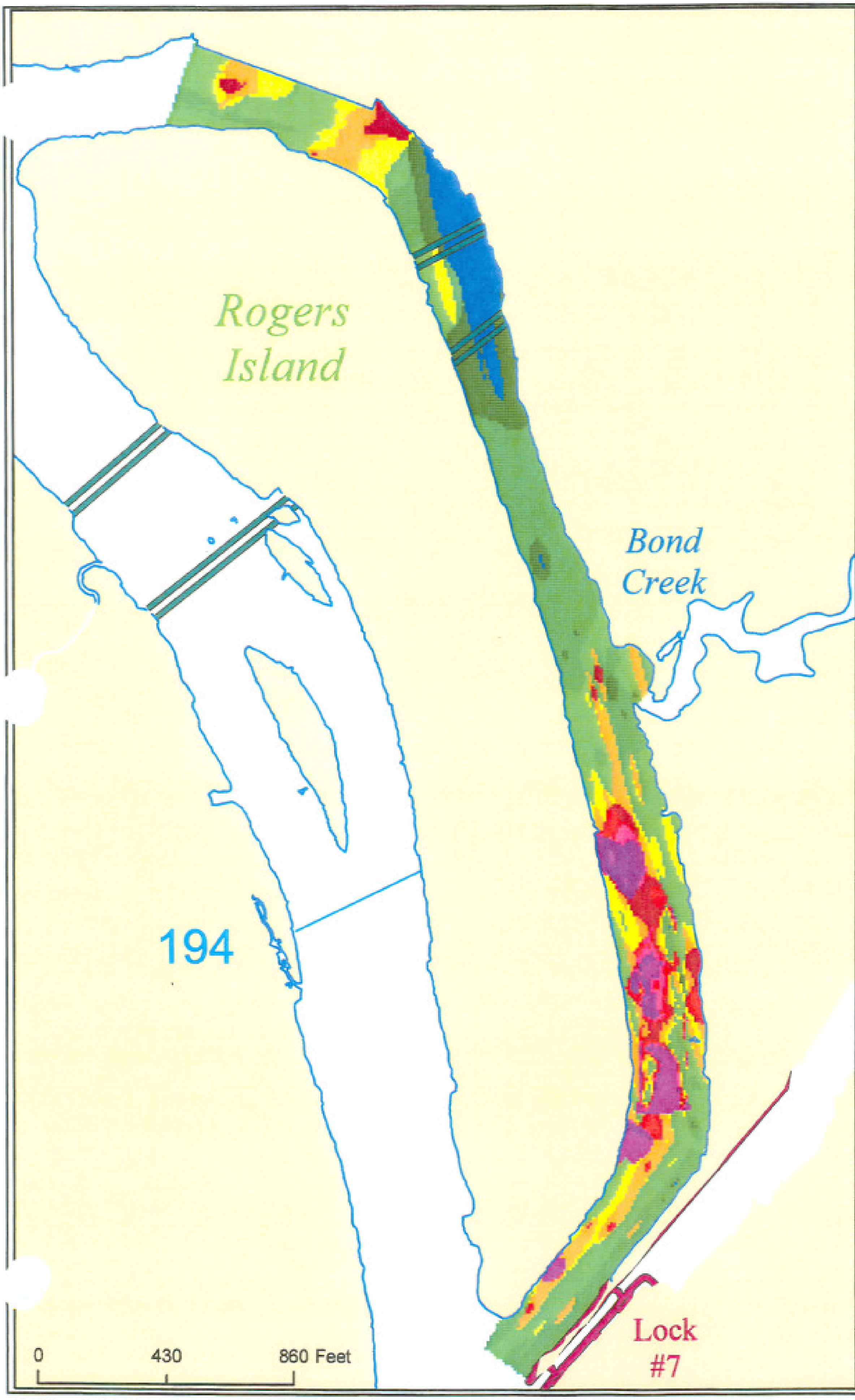
LOCATOR MAP





LEGEND

- River Miles
- Shore Line
- Dams and Locks
- Bridges

- DoC = 0 in.
- DoC = 2 in.
- DoC = 12 in.
- DoC = 24 in.
- DoC = 30 in.
- DoC = 36 in.
- DoC = 42 in.
- DoC = 48 in.
- DoC = 54 in.
- DoC = 60 in.
- > 60 in. DoC

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Figure D-5-1.

Depth of Contamination surface in East Rogers Island

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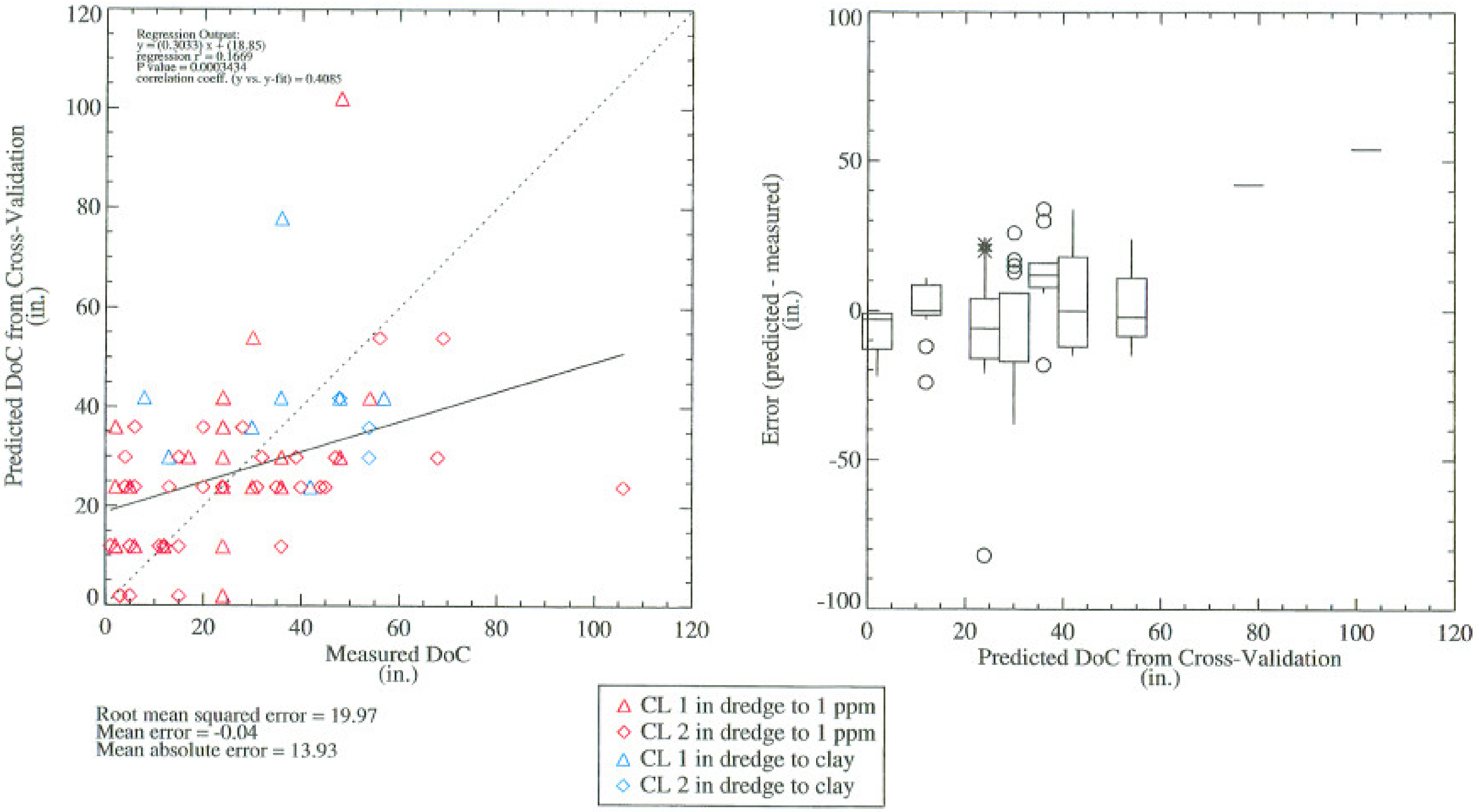

Figure D-6-1. Cross-validation results for 1 mg/kg IDW interpolation for depth of contamination (DoC): East_RIb.

Confidence Level 2D cores are not included. All predicted values on this plot are based on the 1 mg/kg interpolator, even in dredge to clay areas. Black dashed line is the one-to-one line. Solid black line represents linear regression. The right panel contains Tukey box-plots.

Alyssa - D:\GENdad\IDW\20050727\for_cross-validation\idw_1ppm_interp_cross_valid_20050816.pro
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